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SPATIAL PATTERN AND MOVEMENT OF GERMAN COCKROACHES IN URBAN, LOW-INCOME APARTMENTS (DICTYOPTERA: BLATTELLIDAE)

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Abstract.—The spatial pattern and movement of the German cockroach, *Blattella germanica* (L.), were studied in urban apartment buildings in Roanoke, Virginia. Each building (8 m × 32 m) contained six apartments adjacent to each other in a row. The spatial pattern was studied by trapping cockroaches in each apartment for eight weeks. Traps were made from one-qt. Mason jars baited with boiled raisins and a vial of water. A mark-recapture method, using genetic mutant black-body male German cockroaches, was used to study movement of cockroaches within apartment buildings.

German cockroaches were distributed throughout the three apartment buildings, but in each building a large number of cockroaches were "focused" at one or two apartments. Poor sanitary conditions in these apartments probably provided abundant food, water, and harborage for cockroaches. The movement study results indicate that laboratory reared, male German cockroaches can move between adjacent apartments. The large number of cockroaches captured in the apartments adjacent to focus apartments indicates the possibility of movement of field cockroaches between adjacent apartments.

The German cockroach, *Blattella germanica* (L.), is one of the most important household insect pests in the continental United States (Mampe, 1972). In an urban environment, especially in apartment buildings and row houses, this cockroach can occur in large numbers and achieve serious pest status. Wright (1965) reported the German cockroach as the most prevalent cockroach in urban, low-income apartments in North Carolina. A survey taken in 1970, in six New Haven, Connecticut public housing projects, showed that 60% of the apartments were infested with German cockroaches (Moore, 1971). Reierson and Rust (1977) and Ogata et al. (1975) reported the dominance of the German cockroach in apartments and other urban buildings. Cornwell (1968) noted that this species was the pest in 70% of the reported cockroach infestations in Boston city apartments and Gupta et al. (1973) and Wright (1979) found a relationship between household sanitation and German cockroach populations. Investigations of German cockroach habitats and population density include those by Wright and McDaniel (1973), Artyukhina (1972), Ogata (1976), Komiyama and Ogata (1977), Robinson et al. (1980), and Wood (1980).

The prevalence and importance of *B. germanica* in urban environments indicate the need for more field research on its biology and habits. The objectives of this research were to examine the spatial pattern of German cockroaches in three urban apartment buildings.

MATERIALS AND METHODS

Study Area.—The work was conducted in three Roanoke Redevelopment and Housing Authority apartment buildings in Roanoke, Roanoke Co., Virginia from September to November 1977. Each building contained six apartments adjacent to one another in a row. The buildings are 8 m × 32 m, constructed of concrete block, and have a brick veneer outside. There is a basement under one end apartment (apartment 6); the remaining apartments have a shallow crawl space beneath a suspended concrete slab. Each apartment contains approximately 65 m^2 of floor space, divided between two floors; a living room, kitchen, and pantry are on the first level, with two bedrooms and a bathroom on the second level. All the apartments in the three buildings were occupied during the study time. The buildings were labeled A, B, and C for identification.

Sampling Method.—Existing cockroach populations were sampled by using traps made from one-qt. Mason jars. Traps were modified from those used by Reierson and Rust (1977). A tablespoon of boiled raisins and a sponge-wicked vial (4 dram) of water were placed in the jar. A thin film of petroleum jelly was spread on the inside lip of the jar, and a paper towel secured around the outside.

The traps were collected weekly, and replaced with fresh traps. Traps were returned to the laboratory where the nymph and adult cockroaches were separated and counted. First- and second-instar nymphs were not included in the data because of the possibility of ootheca of captured females hatching during the week. The traps were placed in the buildings for eight weeks. During the trapping period the regular chemical pest control program was suspended, and residents were asked to refrain from using insecticides.

Trapping Sites.—Three traps were placed in each apartment: one under the kitchen sink (=kitchen site); one in the pantry (=pantry site); and one under the bathroom sink (=bathroom site). The kitchen site was an enclosed cabinet (0.61 m × 1.3 m) which usually contained cleaning substances, packaged food, and sometimes garbage containers. The stove was adjacent to the kitchen sink cabinet. The pantry site was a small (2 m × 1.8 m) room

Table 1. Comparison of the sanitation rating and the number of German cockroaches captured in apartments for 8 weeks.

Bldg/Apt	Sanitation Rating	Total No. Captured	% of Total Captured	Mean Captured/Wk	S.D.	Range
A/1	G	158	7.8	19.7	10.6	6–38
A/2	B	779	38.7	97.3	35.5	41–142
A/3	B	854	42.4	106.7	85.4	14–292
A/4	G	209	10.4	26.1	12.5	6–43
A/5	G	5	0.2	0.6	0.7	0–2
A/6	G	7	0.3	0.8	1.1	0–2
B/1	B	652	54.4	81.5	20.1	43–105
B/2	G	151	12.6	18.8	15.0	0–35
B/3	G	97	8.1	12.1	6.0	9–21
B/4	G	19	1.6	2.3	2.9	0–7
B/5	B	259	21.6	32.3	11.1	17–52
B/6	G	20	1.7	2.5	1.4	0–4
C/1	G	3	0.2	0.3	0.5	0–1
C/2	G	13	4.7	9.1	7.6	0–22
C/3	G	112	7.3	14.0	15.3	0–49
C/4	G	24	1.5	3.0	3.5	0–8
C/5	G	283	18.3	35.3	23.2	19–72
C/6	B	1048	67.9	131.0	31.1	98–176

lined with wooden shelves and with a door that opened into the kitchen. The pantry usually contained packaged food, non-food items, and sometimes garbage containers. In the bathroom (1.5 m × 2 m), the trap was in the open (not in a cabinet). In apartment 2 (bldg. A) the trap for the bathroom was placed on the top shelf of the small closet adjacent to the bathroom.

The general construction, room furnishings, relative humidity, and temperature in the 18 apartments were nearly equal and constant. The sanitation level in the apartments was variable.

Sanitation Rating.—The sanitation level in the apartments was rated either Good or Bad. A Bad sanitation rating was given to apartments with accumulated newspapers, laundry, garbage, open food containers, unwashed dishes, excessive food scraps, and human excreta (including soiled diapers). A Good sanitation rating was given to apartments with average housekeeping, i.e. with no excessive amounts of food scraps, clutter, or garbage.

Movement Studies.—A mark-recapture method was used to study movement of cockroaches within apartment buildings. Black-body (BB) German cockroaches, characterized by dark body pigmentation (Ross and Cochran, 1966), were used as the marked cockroaches. These genetic mutants were selected because they are easily distinguished without the aid of a microscope.

During the first week of the study, 200 nymphal and virgin adult BB German cockroaches were released in the basement under the end apartment (apartment 6) in each of the three buildings. The traps in the apartments were checked weekly for the presence of BB cockroaches.

RESULTS AND DISCUSSION

Spatial Pattern.—German cockroaches were distributed throughout the three apartment buildings. Table 1 shows that German cockroaches were captured in all the apartments during the study period. In some apartments (A/5, A/6, C/1) the total number of cockroaches captured was small, less than ten. However, there were one or two apartments in each building in which the total number of cockroaches was very large. In apartments A/2, A/3, B/1, and C/6 the mean number of cockroaches captured per week was significantly greater ($P < 0.001$) (Least Squares Means) than in any other apartment.

Ebeling et al. (1967) showed the importance of proximity of food and water to German cockroach survival in the laboratory. Wright (1979) showed a direct relationship between the number of German cockroaches (visually counted) and the sanitation level of a single family dwelling; in houses with poor sanitation, the numbers of cockroaches counted were high. In this study, a sanitation rating of Bad was given to apartments A/2, A/3, B/1, and C/6. These apartments apparently provided food, water, and harborage in sufficient quantities to support the large number of cockroaches "focused" at these locations.

Table 1 shows that all apartments adjacent to "focus apartments" had a sanitation rating of Good, but the mean numbers of cockroaches captured per week were large. In all the apartments adjacent to focus apartments the mean numbers of cockroaches captured per week were significantly greater ($P < 0.001$) (Least Squares Means) than the means for apartments not adjacent to focus apartments. This study shows that apartments with a sanitation rating of Good, but adjacent to a focus apartment, can have a large number of cockroaches. Although food, water, and harborage were not abundant in the adjacent apartment, cockroaches from the large population in the focus apartment may include the adjacent apartment in their foraging and harborage-seeking activity. Movement to adjacent apartments is possible through cracks in the walls and along water and heating pipes.

Movement.—In building A, 11 BB cockroaches were recaptured during the four weeks following the release of 200 in the basement of apartment six: first week, 1 BB in apt. 6; second week, 1 BB in apt. 5; third week, 4 BB in apt. 6, 1 BB in apt. 5, 2 BB in apt. 4; fourth week, 2 BB in apt. 5. No other BB cockroaches were captured in this building. In building B, 1 BB cockroach was recaptured in apt. 5 during the first week following release. In building C, 1 BB cockroach was recaptured in apt. 5 during the third week following release. No other BB cockroaches were captured in bldgs. B and C during the remaining weeks of the study. The results from the movements studies indicate that laboratory reared, virgin, male German cockroaches can move between adjacent apartments. It is not unreasonable to assume that cockroaches in field populations have this same capability. The large numbers of cockroaches captured in the apartments adjacent to focus apartments suggest the possibility of movement of field cockroaches between adjacent apartments.

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